

**Arizona Department of Environmental Quality UST Program  
Release Reporting & Corrective Action Guidance**

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## **SECTION 4: SITE INVESTIGATION**

### **4.1 SITE CHARACTERIZATION**

#### **4.1.1 Introduction**

This section provides guidance for determining the full extent and degree of soil, groundwater, and surface water contamination resulting from the release(s) of regulated substances from UST system(s). This guidance is not intended to address every nuance of a site investigation, and assumes that the user is acquainted with industry standards of practice and has had appropriate field and technical experience with the characterization of UST releases. Industry standards of practice for all aspects of site characterization are available from guidance and standards published by U.S. EPA, American Society of Testing and Materials (ASTM), and the American Petroleum Institute (API). Care should be taken to utilize the most recent versions of the available documents. These documents may be obtained online at the following websites: <http://www.api.org/cat/index.htm>, <http://www.astm.org/>, <http://www.epa.gov/epahome/publications.htm>, and <http://www.ntis.gov>. You may also contact the following organizations in writing or by telephone:

U.S. Environmental Protection Agency  
National Service Center for Environmental Publications (NSCEP)  
P.O. Box 42419  
Cincinnati, OH 45242  
1-800-490-9198  
FAX (513) 489-8695

National Technical Information Service (NTIS)  
Springfield, Virginia 22161  
1-800-553-NTIS (6847) or (703) 605-6000

ASTM  
100 Barr Harbor Drive  
West Conshohocken, Pennsylvania, USA 19428-2959  
1-800-262-1373

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API Publications  
Global Engineering Documents  
15 Inverness Way East  
M/S C303B  
Englewood, CO 80112-5776  
1-800-854-7179

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#### **4.1.2 Site Characterization Objectives**

Site characterization is one of the initial steps in the corrective action process. This typically involves the investigation of soil, groundwater and surface water to determine the nature and extent of contamination, and to assist in the development of an effective remediation strategy.

Site characterization activities should be planned and carried out to meet the following objectives:

- Characterize the type(s) of contaminants resulting from the release(s).
- Develop an accurate understanding of the site geology and hydrology.
- Delineate the distribution of contamination resulting from the release(s).
- Determine potential and actual migration pathways of the contamination.
- Identify and assess existing and potential adverse effects to receptors.
- Aid in developing an effective and appropriate corrective action.

Depending on site-specific conditions, additional information may be collected during the site characterization process which may support latter phases of corrective actions. One example is when, during the site characterization process it becomes apparent that remediation is necessary and that a corrective action plan (CAP) may be required, some components inclusive for a feasibility study (see Section 7) may be conducted during the site characterization phase and prior to submitting a CAP to the department. Another example is when, if laboratory results indicate significant exceedances of the Tier 1 cleanup standards and field work for site characterization remains in progress, representative soil samples may be collected and analyzed for geotechnical parameters that significantly impact the outcome of models used for determining soil leaching or soil vapor flux in higher tier evaluations.

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#### **4.1.3 Conceptual Site Model (CSM)**

The conceptual site model (CSM) is now required within the Site Characterization Report (SCR), and in the Tier 2 or Tier 3 evaluation if submitted. Although the CSM has not previously been a regulatory requirement [A.A.C. R18-12-262(D)5; R18-12-263.01(B)2(g) and 3(g)] of the UST Program and thus not formalized as a discrete stand alone deliverable, the components of the CSM can be seen in every report submitted after a release has been determined. The process of developing the CSM is the same as the process of information gathering during the site characterization and corrective action process. The only difference between previous reporting submittals and the CSM, as described in this guidance, is that the CSM is a consolidated and concise summary of site-specific information collected, which should be briefly and succinctly documented in a chart, decision-matrix, flowtree, checklist, graphical or narrative format. Succinct documentation is provided by referencing those sections of the SCR which provide a discussion of the information and data interpreted in deriving the conclusions represented in the CSM. The CSM represents, to the best of your understanding at any point in the investigation and corrective action process, the source(s), migration pathways, and receptors constituting complete or potentially complete exposure pathways that warrant risk-based evaluation, and possible subsequent remedial action for protection of human health. In order to eliminate those pathways which are incomplete, site-specific data should support this conclusion. Furthermore, for pathways which are or may potentially be complete, thorough site characterization should be conducted for the associated environmental media.

In the early stages of site investigation, preliminary information is usually obtained from the first site visit, and through review of publically available records and data for the site and adjoining properties. This preliminary site information may be used, in combination with professional judgement in assigning conservative assumptions for those aspects of site characterization which are unknown, to develop an initial draft CSM. The function of the initial draft of the CSM is to integrate available site information and identify data gaps so that the site investigation may proceed with appropriate characterization of environmental media.

As site investigation proceeds, additional data is obtained which provides confirmation of complete pathways and elimination of incomplete pathways to update the CSM into a revised CSM which may be used for decision-making for further risk-based tier evaluation and selection of a remedial approach

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among feasible alternatives.

Typically, a CSM should be developed for three different time periods: (i) the current use, (ii) short-term future use, such as a period of construction, and (iii) reasonably foreseeable future use. In many cases, these can be accomplished on one figure. Consideration of current and anticipated future uses ensures that the site-specific decisions will be protective of not only current but also future site use. At sites where the current and future uses are likely to be the same, the current and future CSM would be identical. For example, those sites which utilize an institutional or engineering control, through a Declaration of Environmental Use Restriction (DEUR) [see Section 6.3.9], may restrict future use to that currently in place. The CSM for short-term future use during construction and short-term, acute threats to construction workers can be addressed in the context of the site-specific Health and Safety Plan (HASP).

An exhibit of a CSM is presented in Figure 4.1.3.a, as abstracted from ASTM, 1995, Figure 2. [Note: This figure become available in the future for download in Excel format in color and in black & white from the department web page at [www.adeq.state.az.us/envIRON/waste/ust/](http://www.adeq.state.az.us/envIRON/waste/ust/).] An alternate CSM itemizing more completely the potential receptors and corresponding to the department software for risk-based evaluation is shown in Figure 4.1.3.b. [Note: This software is under development and in the near future may also be downloaded from this web page. Source(s) are indicated by a box on the left side of the figure. Moving left to right across the chart, arrows link the sources to pathways and ultimately to the receptors. The progress across the chart includes all the elements of a complete exposure pathway, namely:

•source	[such as a UST or associated piping]
•initial release mechanism	[such as spills, overfills or leaks]
•secondary source	[contaminated soil or groundwater, or subsurface man-made conduit]
•secondary release mechanism	[transport mechanisms such as dispersion, volatilization, advection]
•pathway	[dermal contact or ingestion of soil or groundwater; inhalation of vapors in indoor air]
•receptors	[such as public or private wells, surface water, ecological resources, elementary school children]

In the examples cited above, these components of the CSM which are complete should be sufficiently characterized to determine the level at which a receptor

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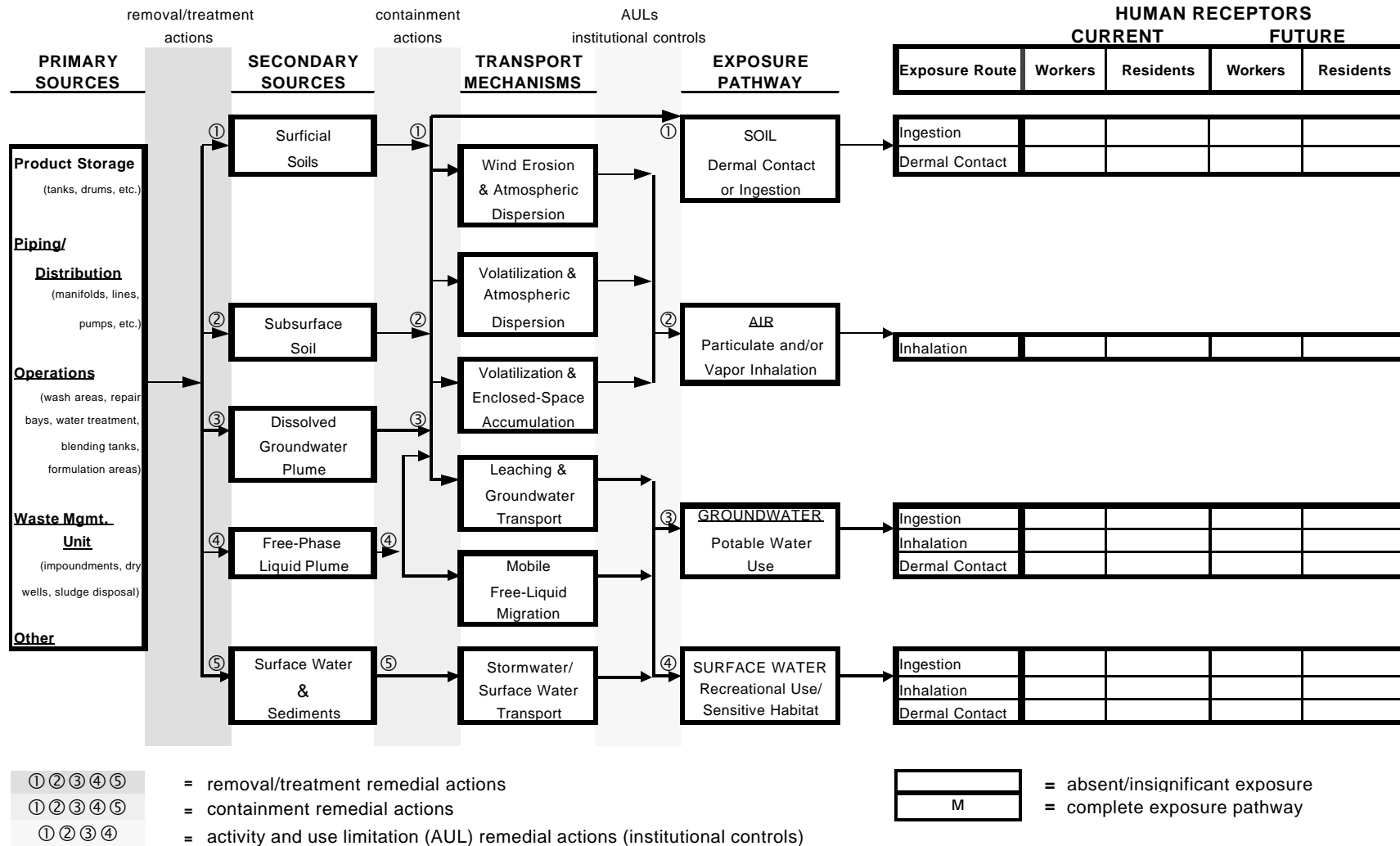
may be exposed to COCs. For those components of the CSM which may lead to a potentially complete exposure pathway, further site characterization or data collection should be conducted to determine if a receptor will be exposed, and at what levels. Focused data collection does not need to proceed further when it can be demonstrated that:

- (i) a receptor is not exposed; or
- (ii) exposure levels do not pose an unacceptable risk; or
- (iii) levels in soil and groundwater and surface water do not exceed tier 1 cleanup levels.

The department recommends that the owner or operator utilize the format presented in the example CSM provided. However, a similar format may be utilized which is appropriate for the subject site.

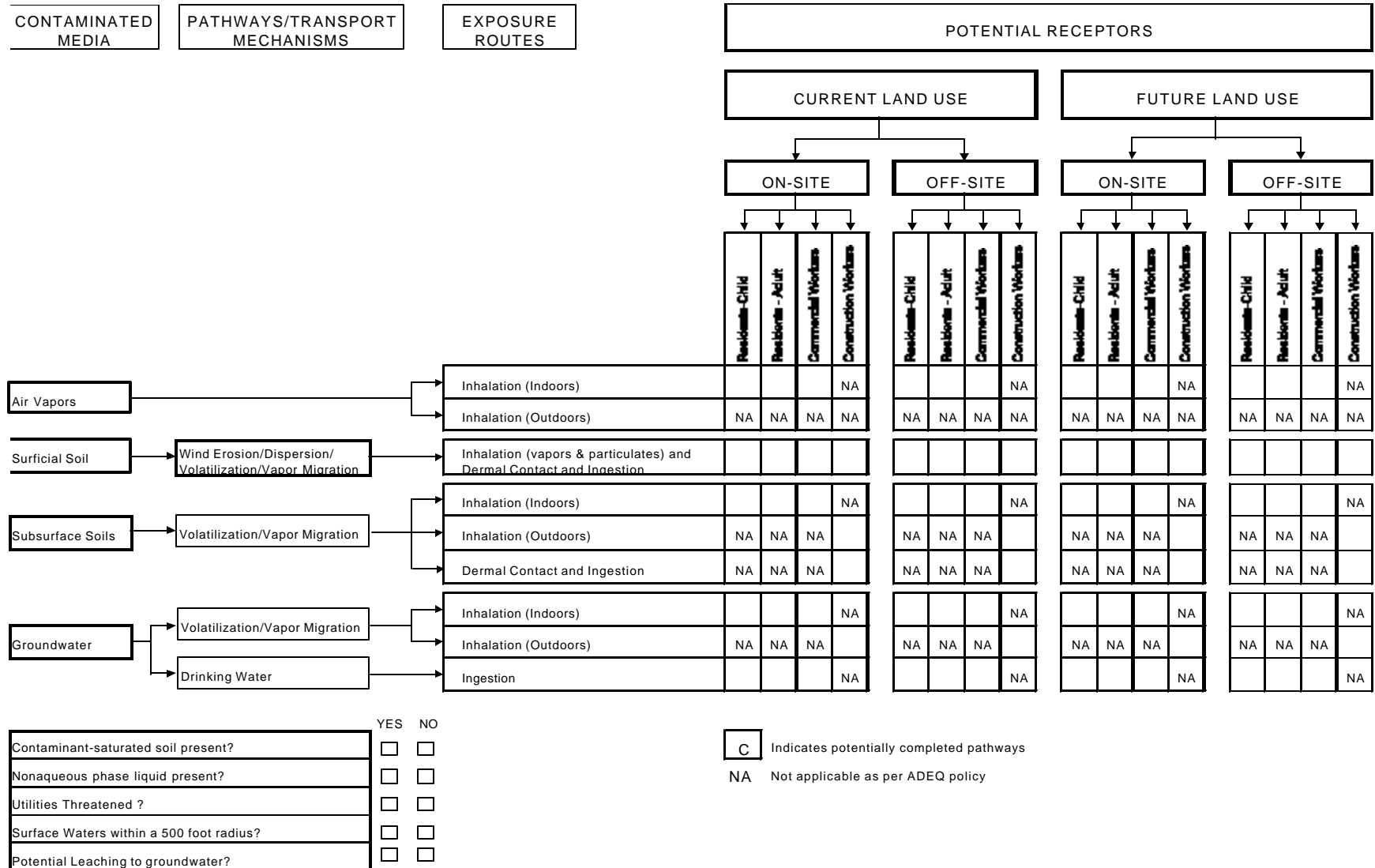
It is the comparison of levels of COCs at the site with levels predicted or measured for receptor exposure, which indicates a potential risk to human health and the environment that should be further evaluated or remediated.

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**Figure 4.1.3.a: Conceptual Site Model adapted from ASTM, 1995**

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**Figure 4.1.3.b: Sample Conceptual Site Model**

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#### **4.1.4 Soil Investigation**

##### **4.1.4.1 Determining Vertical Extent of Soil Contamination**

Investigation of the vertical extent of soil contamination is required for each confirmed release. A soil boring should be placed as close as possible to each confirmed release point. However, site conditions, or the risk of puncturing the UST system or otherwise facilitating a potential release from a UST system, may require greater than desired distances. The vertical extent of soil contamination is considered defined when the sample analytical results document that the concentrations of COCs are at or below the vertical investigative level shown in Table 6.1.2.a. The vertical investigative level is the minimum laboratory reporting limit (MRL) which laboratories, certified by the Arizona Department of Health Services (ADHS) for the analytical method, have agreed to meet in consensus with the UST Program. For those compounds which can be reported by the laboratory by more than one analytical method, the investigative level is the lower reporting limit.

Field investigation of the vertical extent of a chemical of concern (COC) should continue until one of the following occurs:

- Analytical results from samples collected ten feet below the last field detectable evidence of contamination is below the MRL when using a fixed-base analytical laboratory (see exceptions below).
- Analytical results indicate COC concentrations are less than the MRL when using a mobile laboratory (see exception below).
- Groundwater is reached. The department recommends that a groundwater monitor well be installed in the vertical extent boring. However, the required permits must be obtained from the ADWR.
- Competent bedrock<sup>3</sup> is encountered (refer to Appendix D).

This implies that situations will occur in which any given COC may be vertically defined at depths less than that for other COCs present. Therefore, when **all** COCs reported by a given laboratory method are vertically defined, the remaining COCs at the site reported under other laboratory methods should continue to be vertically defined by samples collection and analysis using only these other laboratory methods. For example, BTEX by EPA Method 8021B may be non-detect at a vertical depth of 50 feet bgs. However, petroleum hydrocarbons may be the only other COC present at this depth and is reported

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<sup>3</sup> Bedrock being defined as the top of the solid igneous, metamorphic, or sedimentary rock beneath the alluvium. Caliche is not considered bedrock.

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at 6,000 mg/kg. Therefore, further vertical delineation is required for only petroleum hydrocarbons by method 8015AZR1. Using this same example, we may replace petroleum hydrocarbons with MTBE as the only other COC at 50 feet bgs. In doing so, EPA Method 8260B would need to be used for analyses of samples collected at greater vertical depths. This is because most laboratories are not ADHS certified for MTBE by Method 8021B.

ADEQ strongly recommends the use of an on-site mobile laboratory to assist in determining the vertical extent of soil contamination and to prevent unnecessary mobilizations.

Soil samples for laboratory analysis are not usually collected more frequently than every five vertical feet of drilling, and at least one sample should be collected every ten linear feet of drilling. Samples should be collected in accordance with the guidance provided in Appendices E and F. The following conditions should be considered when selecting soil samples for more frequent collection for laboratory analysis:

- significant changes in lithology
- field screening results indicate a significant rise in contaminant levels

Drilling deeper than 10 feet past the last field-detectable evidence of contamination may be appropriate for a specific LUST location in order to determine the applicable investigative and clean-up standards (*i.e.*, ADEQ SRL or a level protective of water quality, refer to Table 6.1.2.a.).

Soil samples submitted to the laboratory should be analyzed for the groups of COCs listed in Table 4.1.4.a. These groups of COCs are typically present in the petroleum product designated in this table. COCs not reported as target analytes for the methods described in Table 4.1.4.a are usually not warranted for investigation unless significantly contributing to the estimated potential human health risk posed by site-specific conditions at the site. For a more detailed list of potential COCs refer to Table 6.1.2.a. Other analytical methods may be substituted for those noted in Table 4.1.4.a when:

- (i) a laboratory is not ADHS certified on a particular method, OR the recommended method reporting level can not be attained due to matrix or contaminant interferences; and
- (ii) the substitute method(s) is capable of reporting the same target compounds at the recommended method reporting levels; and
- (iii) the substitute method(s) is ADHS certified.

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To help determine the investigative level and clean-up standards, the vertical extent boring may be advanced up to 40 feet beyond the last field-detectable evidence of contamination to assess the presence of groundwater within that interval. If a mobile laboratory is used, the boring should only be advanced up to 30 feet beyond minimum laboratory reporting limits for contamination.

The following criteria should be met before advancing the vertical extent boring to assess the presence of groundwater:

- No reliable information regarding the depth to groundwater beneath the LUST site is available.
- There are no appropriately screened wells having public access or publicly available data within 1/4-mile of the LUST facility to reasonably estimate the depth to groundwater beneath the LUST facility.

When appropriate (*i.e.*, low permeability soils) and in accordance with all applicable ADWR regulations, [A.A.C. R12-15-816(F) and R12-15-815], the vertical extent boring should be allowed to remain open prior to abandonment for a suitable time period to allow groundwater, if present, to enter the boring.<sup>4</sup>

For further information on ADWR requirements, please contact the Notice of Intent Group at 602-417-2470. ADWR requirements currently do not stipulate a fixed period for the determination of groundwater development. A suitable time period should be based on available regional and local hydrogeological information and the lithology encountered during drilling. Additionally, the cost of retaining drilling equipment on site should be assessed relative to the cost for installation of a monitor well in a dry hole during the same mobilization event.

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<sup>4</sup> The department generally does not consider “dry” drill cuttings generated at the time of drilling as an adequate demonstration of not encountering the water table.

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**Table 4.1.4.a Compounds of Concern**

PRODUCT TYPE	SOIL				GROUNDWATER (GW)			
	BTEX	HC	PAH <sup>4</sup>	VOC <sup>5</sup>	BTEX	HC	PAH <sup>4</sup>	VOC <sup>5</sup>
Gasoline	YES	see 2	see 1	YES	YES	NO	YES <sup>3</sup>	YES
Kerosene / Jet Fuel	YES	YES	YES	YES	YES	see 6	YES	YES
Diesel /Light Fuel Oils	YES	YES	YES	YES	YES	see 6	YES	YES
Heavy Fuel/New Oils	see 1	YES	YES	YES	YES	see 6	YES	YES
Used Oil <sup>8</sup>	YES	YES	YES	YES	YES	see 6	YES	YES
Unknown	YES	YES	YES	YES	YES	see 6	YES	YES
Laboratory Analytical Methods <sup>7</sup>	8021 BTEX only	8015AZ 418.1AZ <sup>7</sup>	8310, 8270 base/neutral, 8100	8260, 8021 AZ lists	8021 BTEX only	418.1AZ	8310, 8270 base/neutral, 8100	8260, 8021 AZ lists

**Codes/Notes:**

- 1** Analyze one sample as near the point of release as possible or the location exhibiting the greatest observable indicators of contamination when field screening is not utilized; or from the vertical boring location yielding the highest likely concentrations based on appropriate field screening methodology or laboratory test results. Only if detected, is further delineation required.
- 2** Analyze for HC in soils beneath "gasoline" UST system(s) only when uncertain about the products historically stored or if it is known that other product(s) were previously stored in the UST. Otherwise, HC analysis is not required.
- 3** Analyze for PAHs in the initial GW sample(s) collected from the well located nearest the release point. Test for PAHs, as applicable, in other GW wells if the source well sample results indicate contaminant levels exceeding the applicable clean up standards.
- 4** PAH denotes polycyclic aromatic hydrocarbons. Benzo(a)pyrene is the only PAH with a numeric AWQS. All other PAHs in groundwater and all PAHs without a predetermined SRL for soil, may be subject to investigation and/or clean up under narrative water and site-specific risk-based soil standards, respectively (see Section 6).
- 5** VOC denotes volatile organic compounds which include, but are not limited to, aromatics, alkylated aromatics, aliphatics and additives such as oxygenates and lead scavengers. Additives which have a numeric AWQS are 1,2-dichloroethane (1,2-DCA) and ethylene dibromide (EDB). For groundwater, if the initial round of sampling from each well is non-detect, further sampling for VOC is not required. For soil, analyze three samples for VOC from the vertical extent boring. Analyze two soil samples with the highest contaminant concentration, one above 15 feet bgs and one below 15 feet bgs, based on applicable field screening or laboratory test results. The third soil sample should verify the vertical non-detect. If the maximum concentration exceeds the applicable investigative level for any VOC, further analysis for VOC is required for soil delineation.
- 6** Petroleum Hydrocarbons (HC) analysis may be required when present or potentially present at levels exceeding or violating a narrative AWQS in a receptor well.
- 7** The most current promulgated method under US EPA SW-846 must be utilized and laboratory certified for this method by ADHS. Method 8100 must utilize capillary column. Methods 8310 and 610 must be run by HPLC. Method 418.1AZ may be run on soil samples for screening purposes only.
- 8** Used oils should also be analyzed for these heavy metals: arsenic, barium, cadmium, chromium, lead and zinc.

**Abbreviations:**

BTEX = benzene, toluene, ethyl benzene, total xylenes; HC = Hydrocarbons, C10 to C32; PAH = polynuclear aromatic hydrocarbons; VOC = volatile organic compounds

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**4.1.4.2 Exceptions to the General Guidance for Determining Vertical Extent**

Where collection of split-spoon samples, or other cored samples are not feasible or available (*i.e.*, in coarse-grained soils or consolidated lithologies), the vertical extent of vadose zone contamination may be defined through the installation of a groundwater monitor well(s) in the upper most aquifer (refer to Section 4.1.5). However, if the owner/operator believes further investigation is not feasible, justification should be submitted to the department. The rationale for ceasing further investigative activities should take into account such factors as, but not limited to, the following:

- Depth to groundwater.
- Nature of the lithologic materials, especially the migration pathways.
- Nature and toxicity of released substance(s).
- Nature of the release(s), (*i.e.*, whether the release(s) emanated from pressurized lines, overfills, holes in tanks), and whether concentrations of the released substance(s) in soil matrices are at or below residual saturation.
- Proximity of the release(s) to groundwater or surface water.
- Representativeness of the soil samples collected to *in situ* soil conditions and contaminant concentrations.

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**4.1.4.3 Determining Lateral Extent of Soil Contamination**

The lateral extent of soil contamination should be characterized to document that the concentration of each chemical of concern is at or below the lowest concentration determined under Title 18, Chapter 7, Article 2 for:

- Pre-determined SRLs of Appendix A for residential uses.
- Concentrations that are protective of aquifer water quality and surface water quality standards.
- Concentrations that do not exhibit a hazardous waste characteristic of ignitability, corrosivity, or reactivity.
- Background concentration, if a chemical of concern exists as naturally occurring background at the LUST site.
- Concentrations that are protective of ecological receptors [A.A.C. R18-7-203(b)(3)]<sup>5</sup>.

The pre-determined residential SRLs are the applicable investigative standards when the deepest vertical extent of soil contamination is not located within approximately 30 feet of the historical high groundwater level. However, when the historic high groundwater level is located within approximately 30 feet, the levels protective of groundwater quality are the applicable investigative standard. The level protective of groundwater quality may be assumed to be consistent with the ADEQ Groundwater Protection Level model (1996), based upon the Jury model, and used for determining the minimum groundwater protection level (GPL). Alternatively, site-specific information may be collected which supports the use of alternative input values to parameter variables of the ADEQ model, OR use of an alternative model, in determining a department approved alternative level protective of groundwater.

If the laboratory data collected from the vertical extent boring indicate that contaminant concentrations exceed the applicable investigative level as determined above, then borings (usually a minimum of three) should be drilled to define the lateral extent of contamination. The borings should be drilled to the depth that the vertical extent of soil contamination was considered to be defined (refer to Section 4.1.4.1). Professional judgement may be used to advance drilling to depths greater than the depth of the vertical boring when supported by site-specific conditions. This may occur under conditions of depth variability of coarse-grain lenses or sample non-recovery in coarse-grained material.

The lateral extent borings should be placed evenly around the release point(s)

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5 If site-specific conditions indicate the existence of ecological receptors and complete exposure pathways, please contact the department for assistance in determining an appropriate concentration for the contaminant in soil.

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at approximately 120-degree spacing as site conditions allow. The lateral distance between the initial release location boring and each lateral extent boring should be based on the contaminant concentrations, the vertical extent of contamination, and the lithology that was encountered during the drilling of the vertical extent boring. Typically, lateral borings are placed 15 feet to 30 feet from the vertical boring, but may be less or more dependent on professional judgement. The investigative levels that should not be exceeded by the lateral extent borings are the pre-determined residential SRL or the minimum GPL, which ever is lower.

In the event that placing three borings around the release point(s) is not feasible (i.e., utilities, structures, access issues), the total number of borings to define the lateral extent of contamination may be reduced if no significant stratigraphic variation in the vicinity of the release(s) is observed during the investigation. A reduction in the number of borings may be appropriate under the assumption that the release(s) has a symmetrical geometry. Lithologic information obtained from subsurface investigations and documented in the manner described in the sampling guidance should be used to support the assumption that the contaminant distribution is symmetrical.

#### **4.1.4.4 Capillary Fringe or “Smear Zone” Contamination Investigation**

The capillary fringe is created by groundwater being drawn up from the water table due to capillary forces within the subsurface formation. The thickness of the capillary fringe is dependent upon the site-specific lithology. A smear zone is created when groundwater contamination exists and the watertable elevation fluctuates. The thickness of the smear zone is dependent upon the amount of the site-specific water table fluctuation. The capillary fringe and the smear zone may exist as distinctly separate zones, or may occur within a zone of overlap.

The investigation of the extent of either the capillary fringe or smear zone contamination is usually not necessary for sites requiring only soil investigation, but may be useful for determining the remedial system design and longevity for contaminated groundwater or free product recovery. Investigation for groundwater is discussed in Section 4.1.5. Free product abatement is discussed in Section 3.9. Characterization of impacted soil should not include the capillary fringe if groundwater is not impacted.

Within the context of soil investigation, only qualitative information regarding thickness of the capillary fringe or smear zone lends to completion of soil characterization. This information can be obtained in the course of drilling soil borings for delineation of the unsaturated zone, or monitor well installation. Collection of samples from these zones do not provide quantitative information for the level of contamination in soil. Similarly, installation of soil borings and sample collection to determine the lateral extent of the smear zone beyond the lateral limits of the investigation of the unsaturated zone is not useful within the context of the soil investigation.

Therefore, investigation of the capillary fringe or smear zone outside the scope of the dissolved phase of groundwater contaminant investigation or free product investigation is not warranted. However, investigation of a significant smear zone (*i.e.*, regarding thickness and concentration), which has become isolated from the capillary fringe occurring at deeper elevations due to a sustained drop in the groundwater table, is warranted as part of lateral characterization of soil contamination if the contamination in the smear zone is attributable to the release under investigation.

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#### **4.1.5 Groundwater Investigation**

The owner/operator should conduct a groundwater investigation if data, compiled in the development of the CSM and obtained during the soil investigation, suggests that the groundwater is or may potentially be impacted. The following conditions will usually indicate the need for a groundwater investigation:

- Soil investigations indicate that contamination has migrated within approximately 30 feet of historic high groundwater.
- A representative soil sample could not be obtained which establishes the minimum laboratory reporting level within 30 feet or more of historic high groundwater.

When establishing an historic high or low groundwater level, available local and regional information should be utilized. Otherwise, only recent trends for water levels may be available for documentation. Seasonal or other factors may lend to fluctuations or trends which may be evident upon review of water elevation information. (See Section 7, Corrective Action Plan, for ADWR requirements).

For aquifers, the investigative and clean up standards are the Aquifer Water Quality Standards (AWQS) (A.R.S. §49-223 and A.A.C. R18-11-405 and 406). In accordance with A.R.S. §49-201, an aquifer is defined as “a geologic unit that contains sufficient saturated permeable material to yield usable quantities of water (five gallons per day) to a well or spring”.

Since the backfill materials in a utility trench or in a tank pit are not considered to be geologic units, they do not meet the definition of an aquifer. Therefore, the investigative goals in these materials are not required to meet the AWQS. However, alternative standards should address all potential exposure pathways and must not cause or threaten contamination of an aquifer at concentrations exceeding AWQS.

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**4.1.5.1 Initial Groundwater Investigation**

The initial groundwater investigation should consist of the installation of a single monitor well, at each release point as described above, to determine whether groundwater has been affected and whether the contaminants exceed AWQS. The well(s) should be located in the immediate vicinity of the release(s) [down-gradient of release point(s) if possible] and constructed in accordance with the well construction guidance provided in Appendix G and consistent with ADWR requirements under A.A.C. R12-15-811. Samples should be collected in accordance with the guidance provided in Appendix H and analyzed for compounds listed in Table 4.1.4.a.

Two initial compliance sampling events must be conducted in which the samples are collected using the same sampling methodology and analyzed using the same laboratory analytical methodology. These two consecutive sampling events should be conducted at least 30 days apart, or other time interval, if site-specific fluctuations and trends are known which are likely to capture changes in groundwater quality due to site-specific hydrological or geochemical factors. If the results from the initial two compliance sampling events indicate that contaminant concentrations in the groundwater are at or below the AWQS, additional groundwater investigation may not be necessary. Additional compliance sampling events may be requested at the discretion of the UST Program based on site-specific conditions.

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#### **4.1.5.2 Full Extent of Groundwater Contamination**

The full extent of the groundwater contamination must be characterized if (a) within the initial monitor well(s) free phase floating product is found, or (b) sample analytical results indicate the presence of compounds associated with the UST release(s) in excess of the AWQS (refer to Table 6.1.2.a). To avoid multiple mobilizations to the site, this characterization may be initiated immediately after the installation of the initial monitor well if evidence indicates that the groundwater is affected in excess of the AWQS. Evidence may include the presence of free product observed in the monitor well, or laboratory results from an investigative **non-purge** groundwater sample collected from the initial monitor well and analyzed by a mobile laboratory.

At a minimum, at least two additional monitor wells will be required to fully characterize the extent of groundwater contamination; one down-gradient and one cross-gradient from the release(s). These additional groundwater monitoring wells should be installed such that an extrapolation of the three-dimensional subsurface extent of the contaminant plume may be determined for levels exceeding the AWQS. If the groundwater flow direction is known, the down-gradient monitor well should be located no greater than 300 feet from the point of release(s)<sup>6</sup> in the direction of groundwater flow, and should be placed as near as possible to the periphery of the leading edge of the plume. The position of the down-gradient well is dependent on site-specific conditions which affect the extent of plume migration. The cross-gradient well should be positioned to help determine an accurate direction of groundwater flow, and to establish the relative dispersion, spreading, and cross-gradient extent of the contaminant plume.

The construction of the wells should be in accordance with the well construction guidance provided in Appendix G. Samples should be collected in accordance with the guidance provided in Appendix H and analyzed for compounds listed in Table 6.1.2.a.

An adequate groundwater investigation should determine the azimuth and length of the longitudinal axis, and width of the transverse axis of the contaminant plume. The down-gradient extent of the contaminant plume is required to be defined to levels at or below the AWQS, unless adequate documentation is provided to department to establish why it cannot be or should not be defined. The cross-gradient extent of the contaminant plume should be

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6 Based on applicable studies indicating that typical petroleum contaminant plume lengths to be approximately 300 feet, which assume limitations to factors affecting plume behavior.

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defined to a concentration that will enable the development of an accurate conceptual site model. Three monitor wells may not be sufficient to define the extent of groundwater contamination in other than local circumstances.

The installation of additional monitor wells may be required under any of the following circumstances:

- The down-gradient well does not define the contaminant plume to AWQS.
- The analytical data from the cross-gradient well does not provide adequate information to develop an accurate conceptual site model.
- The groundwater flow direction is not consistent or cannot be adequately determined based on the three monitor wells.
- The initial estimate of the groundwater flow direction was not accurate, and as a result, the down-gradient extent of the plume remains undefined.
- The extent of groundwater contamination needs to be determined between the contaminant plume and receptors, such as supply wells or springs.
- For large hydrocarbon plumes (greater than 300 feet from the source to the down-gradient well), additional cross-gradient wells may be required to develop an accurate conceptual site model.
- The water table has risen above the top of or fallen below the well screen, such that groundwater samples representative of the aquifer contamination at that location of the plume can not be obtained during the course of the approved SCR or CAP schedule.
- Multiple up-gradient and cross-gradient release points have impacted groundwater, and the effect of these impacts upon the LUST release site have not previously been investigated.

The extent of the groundwater contamination will be considered defined when the sampling results of the down-gradient well indicate contaminant concentrations are less than AWQS, and a cross-gradient well provides adequate information to develop an accurate CSM. If results of two consecutive sampling events of the down-gradient well show contaminant concentrations exceeding the AWQS, an additional, down-gradient well may be required. The department may determine, on a site-specific basis, whether or not the extent of contamination is defined despite levels of contamination present in exceedance of the AWQS. Among the criteria which the department may consider in these site-specific evaluations are:

- the level of the AWQS exceedance
- the nature, degree and type of pre-existing contamination

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- current and potential future uses of groundwater
- planned or proposed remedial actions for pre-existing contamination
- other site-specific conditions which may affect types of groundwater uses, remedial options, hydrologic conditions, changes to groundwater quality (e.g., distance to next accessible well location; vertical distance between the screened interval of receptor wells and the contaminant plume; salinity of the groundwater)
- other information provided by the owner or operator

When a COC does not have a numeric AWQS, the extent of contamination is defined in a site-specific manner, and is dependent upon:

- The location of the receptor(s) that is currently or potentially impacted.
- The use of the water by the receptor population.
- The determination of the appropriate levels for protection of human health and/or levels which impair the quality of the water prior to impacts associated with the release.

An up-gradient well **is** necessary if the following situation exists:

- The UST owner/operator is claiming that some or all of the groundwater contamination existing beneath the facility is the result of release source(s) up-gradient of the facility.

Under either of the following conditions, an up-gradient well **may be** necessary:

- The groundwater gradient beneath the facility is flat, and the flow direction is variable.
- It is apparent that remediation of the known contamination is necessary and information regarding the up-gradient groundwater conditions is necessary to choose an effective method of remediation, e.g. monitored natural attenuation or bioaugmentation.

#### **4.1.5.3 Groundwater Monitoring**

The purpose of groundwater monitoring is to collect data for adequate site characterization and for planning remediation. During the site characterization process, the depth to groundwater should typically be measured quarterly for one year to ensure that the complete seasonal variation of the groundwater elevation, flow direction and gradient are documented. Quarterly measurements are based on the sufficiency of existing local watertable information, applicable to the site's hydrologic setting. However, this information may be absent for some areas. Several factors contribute to changes in the groundwater elevation, and should be considered when adopting an alternative measurement schedule. Examples of such factors include duration, frequency and rates of precipitation; pumping rates, location and screen intervals of production wells; presence and type of surface water; transmissivity of geological formation. Alternative measurement should be no more frequent than monthly over a one year period. Regardless of the measurement frequency and duration chosen, the measurement schedule must provide data useful in: (a) determining whether the site is adequately characterized, (b) validating a CSM reliant upon extensive modeling or limited data, or (c) developing a CAP. Once the seasonal variations are documented, the period of monitoring groundwater elevations should be reduced according to site-specific conditions.

Groundwater sampling may be performed up to four consecutive quarters during the characterization phase. Extended periods of sampling are generally not required by the UST Program, but may be determined to be appropriate on a site-specific basis. In situations where a receptor is affected, the UST Program may request additional periods of monitoring. All available groundwater monitoring data should be included in the completed SCR.

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**4.1.6 Surface Water Investigation**

An investigation of surface water should be initiated whenever the following conditions exist:

- C There is evidence that surface water [Arizona Administrative Code (AAC) R18-11-101(45)] has been affected by the release(s).
- C There is evidence that contaminated soils may be in contact with surface water.
- C The UST Program requests an investigation, based on the potential effects of contaminated soil or groundwater on nearby surface water.
- C There is evidence that the highest down-gradient groundwater levels for some portion of the year are at or above the elevation of the down-gradient receiving body of water.

The department recommends that owner/operators consult with the program prior to the initiation of investigation of surface water. Guidance on conducting investigations on impacts to surface water is beyond the scope of this document, and will be issued subsequently in future revisions in conjunction with the Surface Water Program.

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## **4.2 OFF-SITE ACCESS**

It is often essential for owners/operators to obtain access to off-site properties to determine the full extent and degree of contamination. Attempts to gain access should be initiated as soon as it is determined that the contamination emanating from the UST release(s) may have migrated off-site. Attempts to gain off-site access may include an offer for reasonable compensation, monetary or otherwise, appropriate for property conditions and corrective actions to be undertaken on the property. These conditions include, but are not limited to, type and duration of corrective actions, use of property, and disruption of property uses and business activities. All attempts to obtain access should be thoroughly documented. While attempting access, the owner/operator should continue with corrective actions on-site and off-site where access has been obtained.

The department encourages the owner/operator to notify the program of potential off-site access problems as soon as possible. If the owner/operator cannot complete the site characterization due to access issues, and all conditions prescribed in A.R.S. § 49-1022 (a) (b) and (c) are satisfied, the owner and operator may request a corrective action waiver for the property on which access could not be obtained. If the owner/operator wishes to request a waiver, a demonstration must be submitted which indicates that the provisions of § 49-1032 are satisfied. This demonstration must include the following information:

- C Copies of all access-related owner/operator correspondence to the appropriate property owners.
- C Copies of all access-related correspondence from the property owners to the owner/operator.
- C Summaries of access-related discussions/negotiations with property owners, and all reasons provided by the owner/operators for access denial.
- C Copies of access agreements offered to property owners.
- C A map depicting pertinent properties and public right-of-ways (with utility locations identified) and their locations relative to the LUST site.

A.R.S. § 49-1022 requires that access to all suitable properties (i.e. public right-of-ways, adjacent properties) be attempted. The department will evaluate the documentation and the site-specific conditions before proceeding with any A.R.S. §49-1022 actions.

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### **4.3 REPORTING REQUIREMENTS**

A complete SCR, that adequately documents the full extent and degree of contamination, is required to be submitted to the UST Program within 365 days (one year) of reporting the UST release(s), unless otherwise established by the UST Program [A.A.C. R18-12-262(B)]. Among the criteria which the program will consider in establishing an alternative reporting date are:

- The provisions of the preapproval processes under A.R.S. § 49-1052 and 49-1053(L).
- Whether the release poses an immediate or significant risk to public health or the environment.
- Within the context of a negotiated consent order.

If the established reporting due date cannot be met, the department will consider mitigating factors, such as off-site access, permit acquisition, and unusual site constraints, when utilizing its enforcement discretion. Whenever a deadline for the submittal of a complete SCR is missed, or if the UST owner/operator anticipates that such a deadline cannot be met, all relevant information concerning the failure to meet the deadline should be submitted in writing to the department. Failure to submit the SCR or to establish why the deadline could not be met, may result in an ADEQ enforcement action against the UST owner/operator.

The complete SCR must include the Tier 1 evaluation (see Section 6.2). If a Tier 2 or 3 evaluation is conducted, it may be submitted with the SCR if time allows. However, it may be submitted as a stand alone document, or with any report subsequent to the SCR. The time at which the tier evaluation should be submitted is prior to undertaking any corrective actions at the site, or prior to requesting department approval for LUST case closure if corrective actions are not conducted. This allows the department to review the tier evaluation for adequacy when proposed corrective actions and/or site closure is based on complying with site-specific risk-based clean up standards.

#### **4.3.1 Site Characterization Report Contents**

The department requires the submission of a complete SCR (using the following format) that adequately documents the full extent and degree of contamination resulting from a UST release of a regulated substance in accordance with A.A.C. R18-12-262(B) and (D) and as described in Section 4 of this guidance.

The department requests that the following information be submitted to allow

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for a thorough and timely review by the department. Additional information may also be required to address site-specific issues or conditions.

1. A summary site history that includes:
  - a. Information on the release(s), including the nature of the release(s), the regulated substance(s) released, the estimated quantity of the release(s), and the estimated time period when the release(s) was occurring;
  - b. Past and present land use of the facility, and present land use of adjacent properties and each parcel of property potentially impacted by the release(s). The present land use of all properties within 1/4 mile of the outermost extent of contaminated surface water or groundwater must be included if a corrective action standard determined by a Tier 2 or Tier 3 evaluation under the corrective action standards determination of R18-12-263(B) is to be used for water(s) contaminated at the LUST site;
  - c. Name and address of the owner of each property impacted by the release(s) and, if a corrective action standard determined by a Tier 2 or Tier 3 evaluation under the corrective action standards determination of R18-12-263(B) is to be used for surface water and groundwater contamination at the LUST site, the name and address of property owners and other persons using or having rights to use water within 1/4 mile of the outermost extent of contaminated water. ADWR may be contacted for assistance in determining those entities having water rights in the area of interest.
  - d. Events resulting in environmental impacts at the site prior to the release.
2. A concise description of factors considered in and the rationale used for determining the full extent of contamination, including:
  - a. Selection of soil sampling locations and points;
  - b. Selection of the location and number of groundwater wells, if groundwater is encountered during the investigation;
  - c. Selection of surface water sampling locations, if surface water is encountered during the investigation; and
  - d. Any differences from generally accepted industry standards that occurred during the performance of investigation activities and justification for the methodology used to complete the investigation.
3. Information on bedrock, if encountered during the investigation, as follows:
  - a. Depth to bedrock,

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- b. Bedrock lithology, and
  - c. Description of the slope of the vadose zone/bedrock interface.
- 4. The hydrologic characteristics of groundwater and surface water of the local area within 1/4 mile of either the facility boundary or the outermost extent of contamination associated with the release, whichever is the further distance, as follows:
  - a. A description of the local known or estimated depth to groundwater and, if groundwater is threatened or impacted, the gradient, flow direction, confining layers, multiple aquifers, seasonal or historic water table fluctuation, or quality that may affect the construction or location of additional groundwater monitor wells or responses to contaminated soil, surface water or groundwater; and
  - b. A description of the local surface water including the nature and uses of any waters of the United States or any unique waters designation under Title 18, Chapter 11, Article 1, Appendix B. The nature of the surface waters must be identified as perennial, ephemeral, or intermittent, and the known or estimated local gradient and flow direction must be included.
  - c. In cases of potential commingling of off-site contaminant plumes, the following information for the sites contributing to the contaminant plume:
    - i. A brief description of the site lithology;
    - ii. Depth to groundwater;
    - iii. Type and concentrations of COCs;
    - iv. Description of the horizontal and vertical extent of impacted soil;
    - v. Description of the horizontal and vertical extent of impacted groundwater and/or surface water;
    - vi. A figure depicting the location of monitor wells and the extent of the contaminant plume; and
    - vii. Available free product information.
- 5. A description of all remedial corrective actions initiated as of the time of the report.
- 6. A concise summary of the results of the investigation and a statement of intended future corrective actions as follows:
  - a. The extent, location, magnitude and volume of documented soil, surface water and groundwater contamination;
  - b. The volume, contaminant concentration, and disposition of any contaminated soil or water removed from the LUST site;
  - c. A conceptual site model (see Section 4.1.3);
  - d. The LUST site classification described in R18-12-260.01(E);
  - e. The documentation, described under R18-12-263(C), of the Tier

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- 1 evaluation and of each additional tier evaluation performed as of the date of the report must be included; and
  - f. Recommendations for future remedial corrective actions or LUST case closure.
7. A site location map that includes the labeled location of the following that occur within 1/4 mile of either the facility property boundaries or the outer boundaries of the characterized contamination, whichever is the greater area:
- a. Property boundaries of the facility where the release(s) occurred;
  - b. Named and unnamed streets, roads, alleys and other thoroughfares;
  - c. General land use of properties and locations of any schools, day care centers, hospitals, nursing homes, other potentially sensitive receptor populations, and other LUST sites with designated LUST case number;
  - d. Wells discovered or installed during the investigation. Each well must be identified by any assigned ADWR number, and for wells without an assigned ADWR number, the number assigned by the owner or operator;
  - e. Any surface water bodies, including flow direction; and
  - f. Groundwater flow direction determined under or reported for LUST, Superfund and WQARF sites.
8. A site vicinity map that includes the labeled location of the following that occur within 500 feet of either the facility property boundaries or the outer boundaries of the characterized contamination, whichever is the greater area:
- a. Property boundaries of the facility where the release(s) occurred;
  - b. Named and unnamed streets, roads, alleys and other thoroughfares;
  - c. General land use of properties and locations of any schools, day care centers, hospitals, nursing homes, and other potentially sensitive receptor populations;
  - d. All wells discovered or installed during the investigation. Each well must be identified by any assigned ADWR number, and for wells without an assigned ADWR number, the number assigned by the owner or operator;
  - e. Any surface water bodies, including flow direction; and
  - f. Groundwater flow direction.
9. A site plan or plans, as necessary to maintain clarity of the display, that includes the labeled location of the following that occur within the area investigated:
- a. Property boundaries of the facility and other properties;
  - b. Named and unnamed streets, roads, alleys and other

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- thoroughfares;
  - c. Any buildings, structures, or above ground storage tanks on the facility;
  - d. Type and extent of on-site ground-surface cover, indicated as asphalt, concrete, soil, or another specific type of cover;
  - e. The UST involved in the release(s), point of the release(s), and other present and former tanks including all piping and above ground ancillary equipment. The size and contents of each tank must be identified. If any information required by this subsection on tanks, other than the UST that is the cause of the release(s), is not known, estimated information must be provided and indicated as such;
  - f. Area of any existing or previous excavations resulting from UST corrective actions related to this release(s) and the position of all existing excavated soil stockpiles;
  - g. Known above or below ground utility corridors, sewer systems, irrigation canals, and drainage channels within and adjacent to the area investigated;
  - h. Wells discovered or installed during the investigation. Each well must be identified by any assigned ADWR number, and for wells without an assigned ADWR number, the number assigned by the owner or operator;
  - i. Land use of properties that are impacted by the release(s);
  - j. Structures surrounding the facility that are impacted by the release(s);
  - k. Full lateral extent of soil contamination, boreholes and other sample collection locations, including the sampling locations used during any UST closure activities related to the release(s);
  - l. Surface water bodies with all sample collection locations, documented full lateral extent of surface water contamination and the flow direction;
  - m. Groundwater monitor wells, documented full lateral extent of groundwater contamination, and seasonal and historic directions of groundwater flow and hydraulic gradients, if groundwater has been impacted, threatened, or investigated; and
  - n. Groundwater elevation contours and seasonal and historic directions of groundwater flow and hydraulic gradients, if groundwater has been impacted, threatened, or investigated.
10. A tabulation of field screening and laboratory analytical results acquired during the investigation. The tabulations must include the following:
- a. Sample location identification number.
  - b. Sample number.
  - c. Collection depth.

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- d. Date each sample was collected.
- e. Analytical result with unit of measure.
- 11. Copies of laboratory reports and chain-of-custody forms supporting the tabulation described in subsection 10, and any supporting laboratory documents that report any analytical quality assurance and quality control anomalies experienced by the laboratory.
- 12. A tabulation of water level data acquired in investigating the full extent of contamination. The tabulation must include the following:
  - a. Groundwater monitor well site identification number and ADWR registration number.
  - b. Date of measurement.
  - c. Elevation above mean sea level, or other established benchmark, of top of casing, water level, and, if present, free product level.
  - d. Screened interval.
  - e. Depth to water and, if present, free product and thickness of free product.
- 13. A tabulation of wells registered with the ADWR, and any other known or observed wells located within 1/4 mile of the facility property boundary. For ADWR registered wells, the list must include the ADWR registration number, water use category, reported water level, and drill date, if recorded.
- 14. The lithologic log developed for each borehole, excavation, monitor well, and sample collection location installed to investigate the full extent of contamination that contains the following information:
  - a. The identification number assigned to the subsurface penetration;
  - b. Date and method of the subsurface penetration;
  - c. Depth of penetration;
  - d. Depth and description of lithologies encountered see Appendix E);
  - e. Depth of each sample collected including sample identification number;
  - f. Field screening results of each sample collected; and
  - g. Other information describing subsurface lithology.
- 15. The as built construction diagram of each well installed to investigate the full extent of contamination that contains the following:
  - a. The unique identification number assigned to the well;
  - b. Date of installation;
  - c. Total depth and diameter of hole;
  - d. Casing material, diameter, and screened interval;
  - e. Intervals for the annular fill materials described as sand, grout, or another specified material;

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- f. Surface completion information; and
  - g. Identification of the surveyed fixed reference point used to determine the elevation in relation to sea level, or other established benchmark, of the well head and the determined elevation of the well head for groundwater monitor wells.
  - h. Copies of original elevation survey information.
- 16. Additional information the owner or operator determines is necessary to verify that the requirements for site investigations have been met.
- 17. A statement of professional opinion with regard to the adequacy of the site characterization investigation and the SCR in complying with the requirements of A.R.S. § 49-1005 and A.A.C. R18-12-262.